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PATENT & TRADEMARK OFFICE

Af/2834

TRANSMITTAL OF APPEAL BRIEF (Large Entity)

Docket No.
30-4519 CIP (4710)

In Re Application Of: **Nicholas J. DeCristofaro et al.**

Serial No.	Filing Date	Examiner	Group Art Unit
09/506,533	February 17, 2000	Karl I. E. Tamai	2834

Invention:
AMORPHOUS METAL STATOR FOR A RADIAL FLUX ELECTRIC MOTOR

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on **September 12, 2002.**

The fee for filing this Appeal Brief is: **$320.00**

☐ A check in the amount of the fee is enclosed.

☐ The Commissioner has already been authorized to charge fees in this application to a Deposit Account. A duplicate copy of this sheet is enclosed.

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Dated: **November 6, 2002**

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I certify that this document and fee is being deposited on **November 6, 2002** with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

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Ernest D. Buff

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P30LARGE/REV03

Attorney Docket No.: 0017-20CIP / 30-4519CIP

#16/Appeal Brief

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Nicholas DeCristofaro, et al.	Group Art Unit:	2834
Serial No.:	09/506,533	Examiner:	Karl Tamai
Filed:	February 17, 2000		
For:	**AMORPHOUS METAL STATOR FOR A RADIAL FLUX ELECTRIC MOTOR**		
Client Docket No.:	30-4519CIP (4710)		
Attorney Docket No:	0017-20 CIP		

Harkins 12/4/02

BOX BOPAI
Commissioner for Patents
Washington, D.C. 20231

BRIEF FOR APPELLANTS

This Brief is in furtherance of the Notice of Appeal dated September 12, 2002 in the above-identified application. Fees required under 37 C.F.R. 1.17(f), and any petition for extension of time required herein, as well as surcharge fees associated therewith, are set forth in the accompanying Transmittal of Appeal Brief. This Brief is transmitted in triplicate pursuant to 37 C.F.R. 1.192(a).

(1) Real Party in Interest

The real party in interest is Honeywell International, Inc., 101 Columbia Road, Morristown, New Jersey 07962-1057, as evidenced by the Assignments of co-inventors N. J. Decristofaro, D. A. Ngo, R. L. Bye, Jr., and G. E. Fish, executed on February 11, 2000, and of

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, Washington, D.C. 20231.

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Ernest D. Buff
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co-inventor P. J. Stamatis, executed on February 17, 2000, and recorded in the U.S. Patent Office on February 17, 2000, at reel 010632, frame 0258.

(2) Related Appeals and Interferences

There are no other appeals or interferences known to the applicant, to the appellant's legal representative, or to the assignee which will directly affect or be directly affected by, or have a bearing on, the Board's decision in the pending appeal.

(3) Status of Claims

The claims on appeal are claims 1 – 36. A copy of claims 1-36 is set forth in Appendix I.

Claims 37-50 have been cancelled as being directed to a non-elected invention.

Claims 1, 2, 3, 8, 19-22, and 35 stand rejected under 35 U.S.C. §103(a) as being unpatentable over German Patent Document 28 05 438 (the "'438 patent") and U.S. Patent No. 4,255,684 to Mischler et al.

Claims 4, 5, and 23 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. in further view of U.S. Patent No. 2,556,013 to Thomas.

Claims 6, 7, 24, and 25 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent, Mischler et al., Thomas, and further in view of U.S. Patent No. 3,591,819 to Laing.

Claims 9 and 34 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. in further view of U.S. Patent No. 4,197,146 to Frischmann.

Claims 10 and 11 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent, Mischler et al., and Frischmann in further view of U.S. Patent No. 4,409,041 to Datta et al.

Claim 12 stands rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent, Mischler et al., and Frischmann, in further view of U.S. Patent No. 5,922,143 to Vernin et al.

Claims 13 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent, Mischler et al., Frischmann, and Vernin et al., in further view of U.S. Patent 4,881,989 to Yoshizawa et al.

Claims 15-18 and 26-33 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al.

Claims 19-21 and 28-30 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. in further view of U.S. Patent No. 4,763,030 to Clark et al.

Claim 36 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Mischler et al. and U. S. Patent 5,439,534 to Takeuchi et al.

(4) <u>Status of Amendments</u>

The amendment filed July 3, 2002 in response to the final Office Action dated April 17, 2002 is to be entered for purposes of appeal in accordance with the Advisory Action dated August 6, 2002.

(5) Summary of Invention

The present invention provides an amorphous metal stator for a high efficiency radial-flux electric motor. Generally stated, the stator comprises a plurality of segments, each of which comprises a plurality of layers of amorphous metal strips. The plural segments are configured to form a generally cylindrical stator having a plurality of teeth sections or poles protruding radially inward from the inner surface of the stator. In one embodiment, the stator back-iron and teeth are constructed such that radial flux passing through the stator crosses just one air gap when traversing each segment of the stator. In another embodiment, the stator back-iron and teeth are constructed such that radial flux passing through the stator traverses each segment without crossing an air gap. The amorphous metal magnetic strips in the segments are oriented such that a line normal to either the top or bottom surface of each of the strips is substantially perpendicular to the axis of rotation of the rotor used in conjunction with the stator. The invention further provides a brushless radial-flux DC motor comprising the aforementioned stator, along with a rotor rotatingly disposed within the stator and means for supporting the stator and rotor in predetermined positions with respect to each other.

The geometrical structure of the stator, along with the amorphous metal used in its construction, provide it with an advantageous combination of structural and magnetic properties, including low core loss and reluctance. As a consequence, significant benefits are obtained with a motor incorporating this stator, which are not provided by a motor constructed with the crystalline steels conventionally used in motors. Bulk amorphous metal magnetic components constructed in accordance with the present invention dramatically reduce the production of undesirable waste heat during motor operation. The motor's overall electrical efficiency is

markedly improved, substantially reducing or eliminating the need for ventilation, liquid cooling, or structural means for dissipating waste heat to maintain temperature rise within acceptable limits. The low core loss values of the applicants' amorphous metal bulk magnetic components make them especially suited for motors wherein a high pole count or a high rotational speed necessitates a high frequency magnetic excitation, e.g., excitation at above 100 Hz. The inherently high core loss of conventional steels at high frequency renders them unsuitable for use in motors that require high frequency excitation.

Few prior art workers have attempted to incorporate amorphous metals in motors. Production of laminations by punching or stamping amorphous metal is highly problematic owing to the hardness of the material. In addition, the inherently thin gage of these materials, which is required to achieve the amorphous condition, dictates that a large number of layers must be used to attain a given stack height. It is impractical to handle this large number of layers using conventional construction means and equipment. For these reasons, previous attempts to make amorphous metal motors have met with limited technical success, and little or no commercial value.

By way of contrast, applicants' invention provides a motor that overcomes the deficiencies of existing proposals for amorphous metals motors. The structure of the stator used in the present motor has sufficient mechanical integrity to enable to the motor to operate in a variety of demanding applications, while exhibiting low loss and energy efficiency that distinguish it from existing motors.

(6) Issues

(a) Whether claims 1, 2, 3, 8, 19-22, and 35 should be rejected as unpatentable under 35 U.S.C. §103(a) over German Patent Document 28 05 438 (the "'438 patent") and U.S. Patent No. 4,255, 684 to Mischler et al.;

(b) Whether claims 4, 5, and 23 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent and Mischler et al. in further view of U.S. Patent No. 2,556,013 to Thomas;

(c) Whether claims 6, 7, 24, and 25 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent, Mischler et al., Thomas, and further in view of U.S. Patent No. 3,591,819 to Laing;

(d) Whether claims 9 and 34 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent and Mischler et al. in further view of U.S. Patent No. 4,197,146 to Frischmann;

(e) Whether claims 10 and 11 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent, Mischler et al., and Frischmann in further view of U.S. Patent No. 4,409,041 to Datta et al.;

(f) Whether claim 12 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent, Mischler et al., and Frischmann, in further view of U.S. Patent No. 5,922,143 to Vernin et al.;

(g) Whether claims 13 and 14 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent, Mischler et al., Frischmann, and Vernin et al., in further view of U.S. Patent 4,881,989 to Yoshizawa et al.;

(h) Whether claims 15-18 and 26-33 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent and Mischler et al.;

(i) Whether claims 19-21 and 28-30 should be rejected as unpatentable under 35 U.S.C. §103(a) over the '438 patent and Mischler et al. in further view of U.S. Patent No. 4,763,030 to Clark et al.; and

(j) Whether claim 36 should be rejected as unpatentable under 35 U.S.C. §103(a) over Mischler et al. and U. S. Patent 5,439,534 to Takeuchi et al.

(7) <u>Grouping of Claims</u>

Claims 1, 2, 3, 8, and 35 stand or fall together.

Claims 4 and 5 stand or fall together.

Claims 6 and 7 stand or fall together.

Claims 10 and 11 stand or fall together.

Claims 15-18 stand or fall together.

Claims 19-21 stand or fall together.

Claims 24 and 25 stand or fall together.

Claims 28-30 stand or fall together.

Claims 31-33 stand or fall together.

Claims 9, 12, 13, 14, 22, 23, 26, 27, 34, and 36 stand or fall individually.

(8) Argument

I. The amorphous metal stator of claim 1, the amorphous metal stator of claim 22, the amorphous metal stator of claim 26, the brushless radial flux DC motor of claim 34, and the brushless radial flux DC motor of claim 35 meet the conditions for patentability.

A. Independent claims 1, 22, and 35, along with claims 2, 3, 8, and 19-21 dependent from claim 1, meet the conditions for patentability because neither the '438 patent nor Mischler et al., alone or in combination, teaches or suggests the amorphous metal stators of claims 1 and 22 or the brushless radial flux DC motor of claim 35.

The Examiner rejected claims 1, 2, 3, 8, 19-22, and 35 under 35 USC §103(a) on the following basis:

> **Claims 1, 2, 3, 8, 19-22, and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over German Patent 28 05 438 ('438) and US Patent 4,255,684 to Mischler et al. (Mischler). The '438 patent teaches a stator for a motor having a plurality of segments (one pole section and one back iron section) where the flux must cross an air gap between free ends of a tooth section 3 and a back iron section 2. Each of the back iron sections having a top and bottom surface which has a line normal to the surface being perpendicular to the axis of rotation of the rotor. The '438 patent teaches a stator core secured by being pressed into a housing or belted together (outer restraining member) and having self adhesive foil spacers (inner member). The '438 patent teaches the tooth sections 3 being generally straight and the back iron sections 2 being generally bent. The '438 patent does not teach the stator metal being an amorphous metal. Mischler teaches a stator for a motor with a plurality of segments formed from amorphous metal. Mischler teaches a rotor 22 supported within the stator. It is**

inherent that the motor includes a means to support the rotor. It would have been obvious to a person skilled in the art at the time of the invention to construct the stator of the '438 patent with the metal being an amorphous metal because Mischler teaches that amorphous metal is inexpensive to produce and has low magnetic losses.

The '438 patent discloses a motor comprising an iron core made of layers. The iron core consists of separate parts, which form joints having variable reluctance elements inserted therein. Strips of non-magnetic materials such as plastic foil hold the joints apart. Each of the joints opens out to form a large rectangular window near the inner face which may be used to hold coil windings. In operation, the flux must cross an air gap between the ends of a back and a tooth section. This disclosure <u>does not teach</u> that the metal used is an <u>amorphous metal</u>. Thus, the '438 patent teaches a conventional, <u>crystalline</u> metal stator wherein the flux must cross at least one (and likely more than one) air gap.

The structure taught by the '438 patent is further depicted by the Figure thereof, which is reproduced in Appendix II as Figure A1. The motor core is illustrated in perspective view and comprises four back iron segments 2 and four pole shoes 3. Apparently for the sake of clarity, the patentee has illustrated only one of pole shoes 3. The core structure is appointed for use in a radial flux electric motor wherein the rotational axis is coincident with the center axis of the generally cylindrical combination of the four segments 2. Both the Figure and the specification clearly reveal that segments 2 comprise a plurality of layers 2a of circumferentially bent material, while pole shoes 3 comprise a plurality of stacked layers 3a of core material.

The structure of motor 1 of the '438 patent is further elucidated by Figures A2 and A3 which have been prepared by appellants and are reproduced in Appendix II. Referring now to Fig. A2, there is again reproduced the Figure of the '438 patent. Superimposed thereon is the

rotational axis of motor 1, which is labeled as line R-R. This axis lies generally at the center of the stator structure and along the cylindrical axis direction. Fig. A3 shows a plan view of motor 1 corresponding to the perspective view provided by Figs. A1 and A2. It further depicts a generic rotor which is disposed coaxially within the stator and appointed for rotation either in the clockwise direction S as shown, or alternatively, in the opposite, counterclockwise direction. Fig. A2 also depicts the direction normal to the surfaces of layers 3a of pole shoe 3. Such normal directions are depicted at several points of layers 3a, each of the directions being labeled as direction P. In the plan view of Fig. 3, both the rotational axis R-R and the directions P are perpendicular to the plane of the drawing sheet. Therefore, the direction P normal to the surface of layer 3a at any point thereon is <u>parallel to the rotational axis</u> R-R of motor 1. Figs. A2 and A3 further depict the direction normal to any of layers 2a of back iron segments 2 at any point on the surface thereof. These directions are labeled as directions B and are generally radially oriented with respect to the cylindrical symmetry axis, which is also the rotational axis R-R of the motor. In other words, the direction B-B normal to any of back iron layers 2a at any point on the surface thereof generally intersects line R-R and is generally perpendicular thereto.

By way of contrast, present independent claims 1, 22, and 35 each call for a motor stator comprising a plurality of segments, each segment having a plurality of layers of amorphous metal having top and bottom surfaces. Each of claims 1, 22, and 35 further contains a proviso (i) that requires that the layers be oriented such that a line normal to either surface at <u>substantially any point thereon</u> is substantially <u>perpendicular to the axis of rotation</u> of the rotor of the motor.

In claim 1, the term "surface" used in proviso (i) at the end of line 4 clearly derives its antecedent basis from the first occurrence of the word "surface" in the phrase "a top and a

bottom surface" bridging lines 3 and 4. The top and bottom surfaces, in turn, refer to the surfaces of the layers of amorphous metal strip, also in line 3. A similar proviso (i) is also present in claims 22, 26 and 35. The term "surface" is used in the same sense in these claims as it is in claim 1. In particular, all the claims refer to a "line normal to either surface," i.e., a line normal to either the top surface or the bottom surface of any of the layers of amorphous metal. That line is to be taken from a point "thereon," i.e., a point on either the top surface or the bottom surface of one of the layers of amorphous metal.

The meaning of these terms in the context of present claims 1, 22, and 35 is set forth in detail in the specification and drawings, particularly at page 6, lines 20-25. Furthermore, in the Office Action dated October 16, 2001, the Examiner objected to the originally-filed drawings as failing to show every feature of the invention specified in the claims. More specifically, he stated: "Therefore the stator with upper and lower surfaces having lines normal to the axis of rotation in a segment with and without an air gap must be shown or the features cancelled from the claims." (Paragraph 2). Accordingly, applicants' response dated January 16, 2002 amended the Figures and the Specification as follows: (i) Fig. 4a was amended to depict lines N normal to the surfaces of the amorphous metal ribbons of which the tooth section 230 and the back iron section 220 are comprised; (ii) Fig. 5 was amended to depict via line "R" the rotational direction of rotor 100; (iii) the Specification was amended at the paragraph beginning at page 7, line 28, to reference lines N in Fig. 4a, which depict directions normal to the surfaces of the amorphous ribbons comprised in tooth section 230 and back iron section 220; and (iv) the Specification was amended at the paragraph beginning at page 10, line 14 to reference the rotational direction of rotor 100, which rotates about an axis centrally located in the rotor and perpendicular to the plan

of Fig. 5. It is respectfully submitted that the amended specification and drawings, along with the remarks set forth in applicants' January 16 amendment, clearly define the meaning of the term "surface" and provide an adequate description to enable one of ordinary skill to understand that meaning.

However, in Paragraph 17 of the Final Rejection dated April 17, 2002, the Examiner responded to an argument by applicants in connection with the interpretation of the term "lines normal to the surface" with the following statement:

> **The Applicant's argument that the pole shoes and back iron sections of the '438 patent do not conform to the claimed invention is not persuasive. Each SEGMENT of the '438 patent includes a tooth section 3 and a back iron section 2, such that each SEGMENT includes an inner and outer surface at the back iron section 2 that is normal to the axis of rotation, with an air gap between sections 2 and 3. The Applicant's arguments that the claimed stator segments are only possible in light of the Applicant's specification is not persuasive, as the '438 patent teaches the structure except for the amorphous material that is taught by Mishler.**

Applicant/appellants respectfully submit that this statement reflects an incorrect construction of claims 1, 22, and 35. More particularly, applicants' claims use the term "surface" with respect to the top and bottom surfaces of each of the individual laminations used in constructing a stator, not with respect to an entire <u>segment</u> made of stacked laminations. Such a stack admittedly has plural faces, some of which are defined by the aligned edges of the stacked laminations. However, such faces of aligned edges are not "surfaces" in the sense in which that term (defined at page 6, lines 20-25) is used in applicants' claims 1, 22, 26, and 35. These claims therefore cannot not properly be read as referring to lines normal to such faces of stacked edges, nor do they impose any geometrical conditions on such lines. It is submitted that interpreting claims 1, 22, and 35 in the manner implicitly done by the Examiner would, in effect, vitiate the effect of provisos (i) in defining the scope of the respective claims, and would be

contrary to the usage of the term "surface" set forth by applicants and discussed hereinabove in greater detail.

Clearly, the stators disclosed by the '438 patent and the instant application are both comprised of layers of soft magnetic material. However, it may readily be seen that the orientation of layers in the stator disclosed by the '438 patent is substantially different from that required by applicant's claims 1, 22, and 35, because proviso (i) in each of claims 1, 22, and 35 clearly is not satisfied by a large part of the '438 patent stator, e.g., by layers 3a of pole shoes 3 depicted in Figs. A1-A3; their orientation is parallel, not perpendicular. Accordingly, applicants respectfully submit that the Examiner's position that the '438 patent teaches the structure except for the amorphous material that is taught by Mischler cannot be sustained.

Furthermore, it is respectfully submitted that there is no disclosure or suggestion in the '438 patent that would suggest any alternative geometrical configuration for a stator, let alone the particular configuration delineated by present claims 1, 22, and 35. The Examiner has pointed to none. In fact, the teaching of the '438 patent points away from the stator configuration required by claims 1, 22, and 35. The Federal Circuit has pointedly observed, " 'as a general rule,' ... references that teach away cannot serve to create a prima facie case of obviousness." In Re Gurley, 27 F.3d 551, 553, 31 USPQ 2d, 1131, 1132 (Fed. Cir. 1994).

Claims 1, 22, and 35 also delineate structural features that essentially determine the magnetic reluctance of the motor stator. In particular, proviso (ii) of claims 1 and 35 requires that magnetic flux cross one air gap in traversing each segment of the stator, while proviso (ii) of claim 22 requires that flux traverse each segment without crossing an air gap. As set forth in the specification, e.g. at page 3, lines 19-22 in connection with a discussion of the '438 patent as

prior art, the reluctance of the stator is a significant concern in many motor designs. More specifically, a stator structure wherein contiguous layers of the wound, back iron segments and the pole pieces meet only at points, and not at lines, gives rise to undesirably high reluctance. Such is the case with the stator taught by the '438 patent and depicted by Figure A1. Layers 2a and 3a in back iron segments 2 and pole pieces 3, respectively, are mutually perpendicular and thus join each other only at points, in a grid-like pattern, and not along lines. Such a grid-like intersection inherently cannot be present in a stator core having multiple segments wherein the constituent laminations are all perpendicular to the rotation axis of the associated electric motor. Instead, the laminations would join substantially along lines. It is to be emphasized that the Examiner has not pointed to any teaching in the '438 patent that would disclose or suggest any stator structure in which all the segments, including the pole shoes, are comprised of layers of material oriented perpendicular to the rotor axis, instead of parallel as depicted in Fig. A1. This fundamental structural difference between appellant's claimed stator and any stator disclosed or suggested by the '438 patent provides ample basis for predicating patentability of claims 1, 22, and 35 over the '438 patent and Mischler.

Advantageously, the exciting current drawn by a motor having the stator delineated by claims 1, 22, and 35 is lower than that required for a stator of higher reluctance, such as that disclosed by the '438 patent and depicted by Fig. A1. As a result, the motor of the invention delivers more torque and output power for a given input current than a motor employing any stator core disclosed or suggested by the '438 patent. This distinction provides additional support for the patentability of the present claims over the teaching of the '438 reference.

Recognizing that the '438 patent does not disclose or suggest a stator employing amorphous metal strip material, as required by claims 1, 22, and 35, the Examiner has combined the teachings of Mischler et al. and the '438 patent.

Mischler et al. discloses a stator structure for use in a motor which is fabricated using strip material and moldable magnetic composite, either amorphous metal tape and amorphous flake or similar conventional material. Exemplary of the Mischler et al. disclosure is Fig. 1 thereof, reproduced in Appendix II as Fig. A4. As the annotation "FLUX" in Fig. A4 indicates, magnetic flux lines <u>do not cross any air gap</u> while traversing amorphous metal-containing segments 11 and 12. Each of the layers 13 of amorphous metal strip is said to be "continuous" (col. 2, line 59), and thus inherently without any air gap. By way of contrast, traversal of such an air gap is required by appellant's claims 1 and 35. However, the embodiment depicted by Fig. A4 further requires molded composite pole pieces 18 and 19 (col. 2, lines 64-67). Such pole pieces are said to comprise amorphous metal powder or filament, or, alternatively, other materials such as ferrous particles in a binder (col. 1, lines 63-66), and not layers of amorphous metal strips as required for the segments of appellant's claimed stator. A molded composite magnetic material inherently has a myriad of magnetic gaps therein. This property of the Mischler et al. Fig. A4 embodiment is discussed at page 4, lines 1-4, of applicants' specification; the structure it requires is clearly excluded by proviso (ii) of instant claims 1, 22, and 35, respectively.

While the embodiments depicted by Figs. 8 and 9 of Mischler et al. do not comprise a molded composite pole piece, they still employ continuous, nested amorphous metal strip <u>lacking any air gap</u>. Moreover, the ribbon in the pole extension sections in these embodiments, e.g.

sections 43 and 48 depicted by Figs. 8 and 9, is circumferentially disposed about rotor 22. Such an orientation has a strongly adverse effect on the efficiency of the Mischler et al. motor. Magnetic flux emanates predominantly in a radial direction from the magnetic poles of rotor 22, whatever the rotor type. Such is the case for a permanent magnet, wound field, or squirrel cage induction type rotor, *inter alia*. During most of the rotor's rotation, this flux will enter the radially innermost layers of sections 43 or 48 in a direction that is predominantly radial from the rotor. Hence, such flux enters these innermost stator layers predominantly normal to the ribbon plane. As a result, strong, dissipative eddy currents will be induced in the layers. Such eddy currents will markedly increase the observed core loss of the stator and detrimentally decrease the overall energy efficiency of the motor. Overheating and premature failure of the motor are highly likely.

The Mischler et al. patent clearly does not disclose or suggest any structure wherein flux traversing a stator segment crosses one air gap. Rather, each of the embodiments disclosed employs <u>continuous</u> strips of amorphous metal, significantly limiting the types of motor in which their stator structure may be applied and the performance achievable by such motors. The stator of applicants' claim 1 is not so limited. If a continuous segment of the Mischler et al. motor is magnetized (for example, the segment 38 in Mischler et al.'s Fig. 7), then only the right half of the 12 o'clock tooth and the top half of the 3 o'clock tooth are magnetized. The other halves of the 12 o'clock and 3 o'clock teeth represent parts of different, unmagnetized, segments. Effectively, only half of the volume of each tooth is magnetized. Therefore, if segment 38 is magnetized to 1.5 T, the 12 o'clock tooth will perform as if the entire tooth were magnetized to only 0.75T. This would provide <u>half the torque</u> of a tooth fully magnetized to 1.5T.

Furthermore, the Mischler et al. structure using continuous strips is not conducive to the construction of polyphase motors. Such devices, that notably include three phase motors, are widely used in industrial and commercial applications. The Mischler et al. structure inherently is not suited to carry any significant flux from segment to segment, so that winding patterns wherein turns encompass multiple teeth cannot be used effectively. Such configurations are widely used in motor construction. By way of contrast, appellant's stator is not so limited, and can readily accommodate virtually all common motor winding patterns.

The Mischler et al. limitation that the flux does not jump an air gap also places restrictions on the combinations of frequency, speed and torque at which their motor operates. These restrictions, which have heretofore made amorphous metal stators unsuitable for conventional motor applications, have been eliminated by the stator called for by present claims 1, 2, 3, 8, 19-22, and 35. Overall versatility of the motor is improved; operational ranges and levels of speed, frequency and torque are increased. When compared with any stator constructed from the combined teachings of the '438 patent and Mischler et al., the stator recited by present claims 1, 2, 3, 8, 19-22, and 35 is smaller, lighter, much less expensive to construct and far more versatile and efficient in operation.

Applicants respectfully submit that it was not obvious to manufacture an amorphous metal rotor having the structure of the '438 patent. Had it been obvious to do so, Mischler et al. and other prior art workers would have attempted to combine the teachings of the cited references and realized the significant advantages afforded by the stator delineated by applicants' claims. Clearly, up to the time of applicants' invention, no stator having the structure called for by claims 1, 2, 3, 8, 19-22, and 35 had been proposed by any prior art worker, including those

represented on the '438 disclosure and Mischler et al. The prior art stators and their attendant disadvantages are discussed at pages 1 and 2 of the specification. It is submitted that the proposed combination of the '438 disclosure and Mischler et al. can be made only in light of applicants' own disclosure. Even then, any stator constructed from the combined teachings of the '438 disclosure modified in light of Mischler et al. would require substantial reconstruction and redesign which is not fairly taught by the references.

The Examiner has responded to applicants' arguments with respect to the lack of air gap in the Mischler et al. structure as follows:

> **The Applicant's argument that Mishler must have a continuous magnetic circuit is not persuasive. First because there is no such limiting teaching in Mishler. Second because Mishler teaches the equivalence of steel stripe and amorphous tape, such that a person of ordinary skill in the art is merely choosing between known equivalents (as taught by Mishler) when making the stator of the'438 patent from amorphous *[sic]* tape. The Applicant's arguments regarding the rotor with an air gap is not persuasive, because the limitation is part of the non-elected/non-examined claims.**

This contention of the Examiner that the Mischler et al. teaching is not limited to a continuous magnetic circuit is, respectfully, traversed. Applicants are not aware of any disclosure or suggestion in Mischler et al. of a discontinuous circuit, and the Examiner has pointed to none. Moreover, every one of the structures disclosed by Mischler et al. comprises continuous structures, clearly including the embodiments of Figs. 1, 3-5, and 7-9. The amorphous metal tape is repeatedly said to be "continuous" (see, e.g., col. 2, line 59; col. 3, line 18; and claim 4 at col. 5, line 13). While the Mischler et al. disclosure admittedly contemplates the use of certain amorphous metal compositions in the construction of a motor stator, it does not suggest a stator having the geometrical structure required by applicants' claims; this is true of a stator having the one-gap structure set forth in claims 1 and 35 or the no-gap structure delineated

by claim 22. Moreover, there is no suggestion or disclosure in either the '438 patent or Mischler et al. that would motivate combining the references to derive a stator for a radial flux motor having, in combination, a plurality of segments comprised of a plurality of layers of amorphous metal ribbon, each having a top and a bottom surface, and the segments being oriented such that: (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor of the motor; and (ii) when traversing the segment, the flux either crosses one air gap or does not cross an air gap.

Inasmuch as present claims 2, 3, 8, and 19-21 depend directly or indirectly from claim 1 and further limit its subject matter, they are submitted to be patentably unobvious over any combination of Mischler et al. and the '438 German patent, for at least the reasons set forth hereinabove.

Claims 19-21 were further rejected by the Examiner under 35 USC 103(a) as follows:

> **Regarding claims 19-21, the heat treatment, application of a magnetic field, and annealing are method of making limitations that are not germane to the patentability of the apparatus.**

Applicants respectfully submit that heat treatment or annealing, whether or not a magnetic field is applied, <u>structurally alters</u> the stator recited in claims 19-21 and is thus properly germane to the determination of patentability of those claims. As set forth in the specification, e.g. at page 15, lines 7-16, heat treatment enhances the magnetic properties of the amorphous metal strip used in constructing the stator recited by claims 19-21. Moreover, the specification teaches that different forms of heat treatment <u>result in different microstructures</u> within the metal strip. The heat treatment recited at page 15, lines 10-11 modifies a substantially glassy or amorphous microstructure, whereas the heat treatment presented at page 15, lines 17-19 results in the formation of a nanocrystalline microstructure characterized by the presence of a high

density of grains having average size less than about 100 nm. The specification teaches that each of these methods constitutes means for improving the magnetic properties of the amorphous metal strip, notably the core loss.

Significantly, both the '438 patent and Mischler et al. disclosures are devoid of any teaching concerning heat treatment or annealing of amorphous metal materials. As a result, a stator constructed in accordance with their combined teachings would not have the microstructure that results from such heat treatment, and so would not benefit from the improvement in magnetic properties, such as core loss, that attends such structure. A motor comprising a stator having low core loss operates with high efficiency and speed, low production of waste heat, and minimized need for auxiliary cooling means. The significance of low core loss is set forth in the specification, especially at page 16, line 30, through page 17, line 7, and is further discussed hereinbelow in conjunction with the rejection of claims 15-18 and 26-33 over the '438 patent and Mischler et al.

It is well established that a process-like limitation may properly be present in a product claim. *In re Moore*, 439 F.2d. 1232, 169 USPQ 239 (C.C.P.A. 1971). This precept was further amplified by the same court in *In re Garnero*, 162 USPQ 221, 223 (C.C.P.A. 1969):

> However, it seems to us that the recitation of the particles as "interbonded one to another by interfusion between the surfaces of the perlite particles" is as capable of being construed as a structural limitation as "intermixed," "ground in place," "press fitted," "etched," and "welded," all of which at one time or another have been separately held capable of construction as structural, rather than process limitations.

Applicants submit that the limitations recited in claims 19 ("subjected to a heat treatment") and 20 ("a magnetic field having been applied") are properly construed as structural using the same reasoning that led the court to hold "interbonded" to be a structural limitation in

Garnero. As a consequence, the limitations of claims 19 and 20 properly predicate the patentability of these claims over the art cited. Claim 21 is dependent from claim 19 and thus is patentable for at least the same reasons.

Moreover, claims 19 to 21 depend directly or indirectly from claim 1, which is submitted to be patentably unobvious over any combination of Mischler et al. and the '438 German patent, for the reasons set forth hereinabove. It is therefore submitted that dependent claims 19 to 21 are also patentable over the proposed combination of Mischler et al. and the '438 patent for at least the same reasons.

Still further, applicant/appellants respectfully submit that the Mischler et al. disclosure fails to disclose or suggest features a) and b) of present claim 22. Feature a) requires the presence of an inner restraining means for protecting and strengthening at least the tooth sections of the stator, while feature b) requires an outer restraining means for securing the plurality of segments in generally circular abutting relationship. Applicants are unaware of any teaching in Mischler et al. of these features, and the Examiner has pointed to none. The only support structure disclosed by Mischler et al. is the molded composite magnetic pole faces, e.g. faces 18 and 19 depicted by Fig. A4. These pole faces are said by Mischler et al. to "hold together the assembly and contacting pairs of core straight legs" (col. 2, lines 64-67). Such structural and functional differences of these faces clearly distinguish them from features a) and b) of claim 24. The absence of any suggestion in the Mischler et al. patent concerning features a) and b) is submitted to provide additional basis for predicating patentability of claim 22.

In view of the above remarks, it is respectfully submitted that present claims 1, 2, 3, 8, 19-22, and 35 are patentable over the '438 patent and Mischler et al.

Accordingly, withdrawal of the rejection of claims 1, 2, 3, 8, 19-22, and 35 under 35 USC §103(a) is respectfully requested.

B. Claims 4 and 5 (dependent from claim 1) and claim 23 (dependent from claim 22) meet the conditions for patentability because neither the '438 patent, Mischler et al., nor Thomas, either alone or in combination, teaches or suggests the amorphous metal stators of claims 4, 5, and 23.

The Examiner rejected claims 4, 5, and 23 under 35 USC §103(a) as follows:

> **Claims 4, 5, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over the '438 patent and Mischler, in further view of Thomas (US 2556013). The '438 patent teaches the wedges 7 having a self adhesive to bond the teeth sections 3 and the back iron sections 2, where the adhesive does not include the first free end 5. The self adhesive inherently covers a substantial portion of the stator, such that the adhesive bonds to both the tooth and the back iron sections. The '438 patent and Mischler teach every aspect of the invention except a steel band peripherally around the stator. Thomas teaches a steel band 2 to secure a laminated stator core 3. It would have been obvious to a person skilled in the art at the time of the invention to construct the stator of the '438 patent and Mischler with the steel band of Thomas because steel has a good tensile strength and because the '438 patent teaches the stator core is secured in a frame.**

The Examiner's statement that the '438 patent and Mischler et al. teach every aspect of the invention except a peripheral steel band is, respectfully, traversed.

As discussed hereinabove in connection with the rejection of claims 1, 2, 3, 8, 19-22 under 35 USC §103(a), over the '438 patent and Mischler et al., present claim 1 calls for a stator comprised of segments, each of which comprises a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Even

taking the '438 patent and Mischler et al. teachings together, there is not provided any suggestion whatsoever concerning a stator that satisfies the combined requirements of provisos (i) and (ii).

Like Mischler et al., Thomas does not disclose or suggest an amorphous metal stator wherein the flux crosses only one air gap. Moreover, Thomas teaches a stator composed of stacked laminations, each having a surface whose normal is parallel, not perpendicular, to the axis of rotation of the rotor with which the stator is associated, contrary to the orientational requirement discussed hereinabove in connection with the 103(a) rejection of claims 1, 2, 3, 8, 19-22, and 35. Thomas does not teach an amorphous metal stator that is not brittle, and which exhibits increased magnetic permeability and overall efficiency without adverse thermal characteristics. In this respect, Thomas does not add to the teaching of the '438 patent and Mischler et al. and cannot be combined therewith to render obvious a stator having the geometrical form delineated by claim 1, let alone the particular stator recited by claims 4 and 5 dependent thereon. When compared to any stator constructed in view of the teaching of the '438 patent, modified in light of Mischler et al. and further modified in light of Thomas, the stator required by present claims 4 and 5 exhibits increased economy of construction and improved operating versatility and efficiency.

In addition, claim 23 inherits from claim 22 the requirement of inner and outer restraining means. The Examiner has not pointed to any disclosure or suggestion in Thomas of an inner restraining means. As set forth in claim 22, the inner restraining means provides protection and strengthening for at least the tooth section of the claimed stator. Such functions are not provided by any stator constructed in accordance with the combined teaching of the '438 patent, Mischler et al., and Thomas.

Accordingly, applicants respectfully submit that claims 4, 5, and 23 are patentable over the combination of the '438 patent, Mischler et al., and Thomas. Withdrawal of the rejection of claims 4, 5, and 23 under 35 USC §103(a) is respectfully requested.

C. Claims 6 and 7 (dependent from claim 1), and claims 24 and 25 (dependent from claim 22) meet the conditions for patentability because neither the '438 patent, Mischler et al., Thomas, nor Laing, either alone or in combination, teaches or suggests the amorphous metal stators of claims 6, 7, 24, and 25.

Claims 6, 7, 24, and 25 were rejected under 35 USC 103(a) on the following basis:

> **Claims 6, 7, 24, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over the '438 patent, Mischler, and Thomas, in further view of Laing (US 3591819). The '438 patent, Mischler, and Thomas teach every aspect of the invention except the bonding material being an epoxy resin and the inner restraining member being a bonding material and a metal band. Laing teaches a laminated stator having a plurality of sections, where the sections are held together by a synthetic resin and a rivet. The examiner takes official notice that an epoxy resin is well known synthetic resin in the motor art. It is inherent that the rivet is metal. It would have been obvious to a person skilled in the art at the time of the invention to construct the stator of the `438 patent, Mischler, and Thomas with the bonding material being a resin because Laing teaches that synthetic resins are a known binding material between stator lamination sections, with the resin being an epoxy resin because it is easily molded around the laminations, and with the rivet (banding) securing the tooth laminations together because Laing teaches that both a rivet and resin are used to secure the laminations together.**

For the reasons set forth above in conjunction with the rejection of claims 4, 5, and 23 under 35 U.S.C. § 103(a) over the '438 patent, Mischler et al., and Thomas, applicants respectfully traverse the statement that the '438 patent, Mischler et al., and Thomas teach every aspect of the invention except the bonding material being an epoxy resin and the inner restraining member being a bonding material and a metal band. It is submitted that Thomas does not cure the lack of disclosure in the '438 patent and Mischler et al. concerning a stator

comprising amorphous metal strips oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Claims 6 and 7 clearly inherit these limitations from claim 1.

Like Mischler et al. and Thomas, Laing does not disclose or suggest amorphous metal stators wherein the flux crosses only one air gap. Like Thomas, Laing also teaches a stator composed of stacked laminations, each having a surface whose normal is parallel, not perpendicular, to the axis of rotation of the rotor with which the stator is associated. Further, Laing does not teach an amorphous metal stator which is not brittle, and which exhibits enhanced magnetic permeability and overall efficiency without adverse thermal characteristics. In this respect, Laing does not add to the teachings of the '438 patent, Mischler et al. and Thomas. Nor does it cure the lack of disclosure of the basic structure required by claim 1, from which claims 6-7 depend. As a result, it cannot be combined with the '438 patent, Mischler et al. and Thomas to render obvious the invention recited by present claims 6 and 7. Any stator constructed from the combined teachings of the '438 patent, Mischler et al., Thomas and Laing would still lack the structure and advantageous properties of the stator delineated by present claims 6 and 7, and as such would be far more expensive to construct and operate.

The Examiner has stated that applicants are not viewing the cited references in combination. This statement is, respectfully, traversed. With respect to the rejection of claims 6, 7, 24, and 25, the Examiner's rejection indicates that '438, Mischler et al., and Thomas teach every aspect of the invention except the bonding material being an epoxy resin and the inner restraining member being a bonding material and a metal band. Laing is presented as teaching a

laminated stator having a plurality of sections, where the sections are held together by a synthetic resin and a rivet. As set forth above in connection with the rejection of claims 4, 5, and 23, even in combination, the '438, Mischler et al., and Thomas references fail to disclose applicants' claimed structure as recited by independent claims 1 and 22, from which claims 6, 7, 24, and 25 depend. The Examiner has not pointed to any teaching in Laing that cures this deficiency or any suggestion in Laing that would motivate a skilled artisan to modify the combined teaching of the '438, Mischler et al., and Thomas references to produce the structures required by present claims 6, 7, 24, and 25. It is thus respectively submitted that applicants' reading is consistent with the combined teaching of the references and is not the result of reading any of the references individually.

Accordingly, reconsideration of the rejection of claims 6, 7, 24, and 25 as being unpatentable over the '438 patent, Mischler et al., Thomas and Laing is respectfully requested.

D. Claim 9 (dependent from claim 1) and claim 34 (dependent from claim 26) meet the conditions for patentability because neither the '438 patent, Mischler et al., nor Frischmann, either alone or in combination, teaches or suggests the amorphous metal stator of claims 9 and 34.

Claims 9 and 34 were rejected as unpatentable under 35 USC 103(a) as follows:

Claims 9 and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over '438 and Mischler, in further view of Frischmann(US 4197146). The '438 patent and Mischler teach every aspect of the invention except the specific atomic composition of the amorphous metal. Frischmann teaches the amorphous metal can made up of ONE OR MORE OF THE FOLLOWING: Fe, Ni, or Co from 70-90% which can be replace by Mo, W, Cr, and V from 70-90%, and C, B,P from 10-30% which can be replaced by AI, Sn, Sb, Ge, In and Be from 10-30%(which includes Si, AI, and Ge between 6-20%). Frischmann teaches that the elements within the group are interchangeable and that more than one could be used, which includes Y+Z replaced by In, Sn, or Sb. Frischmann teaches an impurity of C being 0-2% which includes the range of 0-1%. It would have been obvious to a person skilled in the art at the time of

the invention to construct the stator of the '438 patent and Mischler with MYB composition, with M replaced by up to 10% Mo, W, Cr, or V because Frischmann teaches that more than one M element may be used, with the (Y+Z) replaced by In, Sn, or Sb because Frischmann teaches that more than one Y and Z elements can be used, and because it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

As set forth hereinabove in connection with the rejection of claims 1, 2, 3, 8, 19-22, and 35 under 35 U.S.C. § 103(a), applicants respectfully traverse the indication that the '438 patent and Mischler et al. disclose a stator having the structure required by either claim 1 or claim 26, from which claims 9 and 34 depend, respectively.

Frischmann discloses an electrical magnetic component that is said to comprise a magnetic metal which is at least 50% amorphous and is characterized by compacted <u>discontinuous</u> substantially oblate spheroidal flakes having a thickness between about 0.0005" and about 0.002", a length between about 0.01" and about 1", and a width between about 0.01" and about 1". Such a component is disclosed as useful in constructing devices including motors and transformers. However, the discontinuous nature of the Frischmann compacted component inherently results in a very large number of air gaps therewithin, since flux must perforce cross a discontinuity at each passage from particle to particle. As a result, any component constructed in accordance with the Frischmann teaching does not satisfy the requirement of the respective provisos (ii) of claims 1 and 26 and is inherently incapable of exhibiting enhanced magnetic permeability and overall operational efficiency without adverse thermal characteristics. While Frischmann discloses an amorphous metal composition said to be useful for fabricating electrical magnetic components, any resulting stator lacks the advantageous features afforded by the stator delineated by applicants' claims 9 and 34. As a result of the low magnetic permeability of the

portion of the stator that comprises compacted, discontinuous magnetic particles, the overall magnetic reluctance of the Frischmann stator is far higher than that of applicants' stator, which has relatively low reluctance, since flux traverses the segments thereof crossing either one air gap (proviso (ii) of claim 1, from which claim 9 depends) or no gaps (proviso (ii) of claim 26, from which claim 34 depends). Moreover, Frischmann does not remedy the lack of disclosure in the '438 patent and Mischler et al. concerning the particular orientation of amorphous metal strips called for by claims 9 and 34. In these respects, Frischmann does not add to the teaching of the '438 patent and Mischler et al., and cannot be combined therewith to render obvious the invention recited by claims 9 and 34.

Still further, the stator of claim 34 inherits from claim 26 the limitation that its core loss be less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max}, wherein L is given by the formula $L = 0.0074 f (B_{max})^{1.3} + 0.000282 f^{1.5} (B_{max})^{2.4}$, the core loss, excitation frequency and peak induction level being measured in watts per kilogram, hertz, and teslas, respectively. Neither the '438 nor Mischler et al. patents provide any numerical core loss values, let alone the advantageously low core loss required by claim 26, and thus, claim 34. As set forth in greater detail hereinbelow in connection with the rejection of claims 15-28 and 36-33 under 35 USC §103(a), attainment of such a low core loss by a structure suitable for use in constructing a motor is not disclosed or suggested by the art applied in the present rejection.

Accordingly, reconsideration of the rejection of claims 9 and 34 under 35 U.S.C. §103(a) over the '438 patent, Mischler et al. and Frischmann is respectfully requested.

E. Claims 10 and 11 (dependent from claim 1) meet the conditions for patentability because neither the '438 patent, Mischler et al., nor Datta et al., either alone or in combination, teaches or suggests the amorphous metal stator of claims 10 and 11.

Claims 10 and 11 were rejected under 35 USC 103(a) as follows:

> **Claims 10 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over the '438 patent, Mischler; and Frischmann, in further view of Datta et al. (US 4,409,041). The '438 patent, Mischler, and Frischmann teach every aspect of the invention except the FeBSi formula. Datta teaches the FeBSi formula with the ranged and number claimed by' the applicant. It would have been obvious to a person of ordinary skill in the art at the time of the invention to construct the stator of `438, Mishcler, and Frischmann with the amorphous material as set forth in claims 10 and 11, because Datta suggests the disclosed range and because Datta suggests the disclosed range to enhance the magnetic properties.**

The Examiner's indication that the '438 patent, Mischler et al., and Frischmann teach every aspect of the invention except the FeBSi formula is, respectfully, traversed. As set forth hereinabove in connection with the remarks on the rejection of claims 9 and 34 under 35 U.S.C. §103(a), the combination of the '438 patent, Mischler et al., and Frischmann fails to disclose a stator having the structure required by claim 1, from which claims 10 and 11 indirectly depend.

The Datta et al. disclosure is directed to an iron-based, boron containing magnetic alloy having at least 85 percent of its structure in the form of an amorphous metal matrix annealed in the absence of a magnetic field at a temperature and for a time sufficient to induce precipitation therein of discrete particles of its constituents. No disclosure or suggestion is provided by Datta et al. of the desirability of using amorphous metal in the construction of electric motor components. Moreover, the disclosure of magnetic properties found in Datta et al. is directed to high frequency properties. Each of the examples in Datta et al. discloses properties measured on a magnetic core having a closed magnetic path and carried out e.g. at a frequency of 50 kHz and

at an induction level of 0.1 T. One skilled in the art would recognize that losses measured in an open magnetic circuit are higher than those seen in a closed path, as discussed in more detail by applicants in the specification at page 17, lines 20-31.

Clearly the Datta et al. disclosure is directed to core applications, not to motors or other rotating devices. Applicants thus submit that one of ordinary skill would not be motivated to combine the Datta et al. disclosure with any of the '438 patent, Mischler et al., and Frischmann. However, even assuming *arguendo* that the combination of the '438 patent, Mischler et al., and Frischmann with Datta et al. were to be made, the resulting stator would still lack the advantageous structure and properties afforded by applicants' stator, as recited by claims 10 and 11. More specifically, the stator would not have in combination a structure having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. As a consequence, any stator constructed in accordance with the combined teachings of the cited references would lack the advantageous combination of magnetic properties, including high induction and low material cost (see page 14, line 29, to page 15, line 5 of applicants' specification) afforded by the stator of present claims 10 and 11. For these reasons, applicants respectfully submit that the stator recited by claims 10 and 11 is patentable over any combination of the '438 patent, Mischler et al., Frischmann, and Datta et al.

Accordingly, reconsideration of the rejection of claims 10 and 11 under 35 U.S.C. §103(a) as being obvious over the '438 patent, Mischler et al., Frischmann, and Datta et al.is respectfully requested.

F. Claim 12 (dependent from claim 1) meets the conditions for patentability because neither the '438 patent, Mischler et al., Frischmann, nor Vernin et al., either alone or in combination, teaches or suggests the amorphous metal stator of claim 12.

Claim 12 was rejected under 35 USC 103(a) on the following basis:

> **Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over the '438 patent, Mischler, and Frischmann, in further view of Vernin et al. (US 5,922,143). The '438 patent, Mischler, and Frischmann teach every aspect of the invention except nanocrystalline microstructure. Vernin teaches than a nanocrystalline structure is suitable for magnetic cores. It would have been obvious to a person of ordinary skill in the art at the time of the invention to construct the stator of `438, Mischler, and Frischmann with the heat treated nanocrystal microstructure because Vernin teaches the nanostructure is good for magnetic cores.**

The Vernin et al. patent discloses a process for manufacturing a magnetic core made of an iron-based soft magnetic alloy having a nanocrystalline structure. The alloy is formed into a toroidal magnetic core and heat-treated based on particular conditions determined on the basis of the use envisaged for the magnetic core. No suggestion or disclosure is provided in the Vernin et al. patent of application of nanocrystalline alloys in motors or other rotating electrical machinery. As discussed hereinabove in connection with the rejection of claims 10 and 11 over the '438 patent, Mischler et al., and Frischmann, in further view of U.S. Patent No. 4,409,041 to Datta et al., applicants submit that one of ordinary skill would not be motivated to combine the Vernin et al. disclosure, which is directed to magnetic core applications, with any of the '438 patent, Mischler et al., and Frischmann, each of which discloses aspects of electric motor construction.

The Examiner's statement that a motor is in the same field of endeavor as a magnetic device with an amorphous core is, respectfully, traversed. More specifically, the art recognizes a clear distinction between magnetic materials suitable for use in static core devices (e.g., transformers and inductors) and in dynamic devices (e.g., motors, generators, and other rotating electrical machines). A skilled person would not be motivated to consider both classes of materials on an equal footing, or to infer the desirability of a material for use in one device class from a teaching of the desirability of that material in the context of the other class. More particularly, designers of transformers and motors would recognize different materials as best suited for use in the respective devices.

The distinction arises from fundamental differences in the pattern of magnetization process occurring during operation of the respective devices. Generally speaking, the time-dependent magnetic excitation in dynamic devices (e.g., motors and generators) varies in both direction and magnitude, whereas the excitation in static devices varies in magnitude, but with little or no directional variation.

More specifically, the vectorial magnetization developed in each volume element of an operating transformer or inductor core is directed along a single direction, which is characteristic for that element. During each AC excitation cycle the magnitude of the magnetization in each volume element varies, most often sinusoidally, but the direction of magnetization in each element remains predominantly along a single spatial direction.[1] As a result, high performance static devices such as transformers and inductors are appropriately designed using magnetic materials whose magnetic properties are anisotropic. Such materials exhibit markedly different

[1] For the most common situation in which the excitation is bipolar the magnetization is in opposite directions, but along a common axis, during the respective halves of the AC cycle.

magnetic characteristics when magnetically excited in different geometrical directions within the strip plane.

The situation in an operating motor is quite different. In most cases, both the direction and magnitude of magnetization in significant portions of either a rotor or stator may vary continuously as the motor operates. Hence, motor components are ordinarily designed with isotropic materials, i.e., materials whose magnetic behavior is substantially independent of the direction in which they are magnetically excited.

Applicant/appellants respectfully submit that merely locating every element of claim 12 in one of the references of a proposed combination is insufficient to render the claim unpatentable as being obvious under 35 USC §103(a), absent a proper motivation to combine. As the Federal Circuit has stated in *In re Rouffet*, 47 USPQ 2d 1453, 1457 (Fed. Cir. 1998),

> ". . . 'virtually all [inventions] are combinations of old elements.' *Environmental Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 698, 218 USPQ 865, 870 (Fed. Cir. 1983); *see also Richdel, Inc. v. Sunspool Corp.*, 714 F.2d 1573, 1579-80, 219 USPQ 8, 12 (Fed. Cir. 1983) ('Most, if not all, inventions are combinations and mostly of old elements.'). Therefore an examiner may often find every element of a claimed invention in the prior art. If identification of each claimed element in the prior art were sufficient to negate patentability, very few patents would ever issue. Furthermore, rejecting patents solely by finding prior art corollaries for the claimed elements would permit an examiner to use the claimed invention itself as a blueprint for piecing together elements in the prior art to defeat the patentability of the claimed invention. Such an approach would be 'an illogical and inappropriate process by which to determine patentability.'" *Sensonics, Inc. v. Aerosonic Corp.*, 81 F.3d 1566, 1570, 38 USPQ 2d 1551, 1554 (Fed. Cir. 1996).

Applicant/appellants respectfully submit that the aforementioned considerations by which materials for static and dynamic magnetic devices are distinguished negates any alleged motivation for the proposed combination of Vernin et al. with the '438 patent, Mischler et al., and Frischmann. However, even if the Examiner's proposed combination were to be made, any

resultant device would still not satisfy the requirements of applicant/appellants' claim 12. As discussed hereinabove, applicant/appellants' claim 1 calls for a stator comprised of segments, each of which comprises a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Applicants' claim 12 inherits these limitations. None of the cited references or any combination thereof suggests this combination of structural features. In contrast, the presence of these features in applicants' stator as recited by claim 12 results in low core loss and thus a motor that is smaller, lighter, less expensive to construct and more versatile and efficient in operation than a motor employing a prior art stator.

As previously discussed, the low value of core loss afforded by the present stator results in a motor that is more efficient, generates less waste heat that must be dissipated, and is capable of higher speed operation than a motor employing any conventional steel core material. As discussed in detail by the specification, e.g. at page 16, lines 18-19 and 27-29, stators employing nanocrystalline alloy strip are especially preferred for motors wherein minimum size and high speed operation are desired.

It is therefore submitted that the proposed combination of Vernin et al. with the '438 patent, Mischler et al., and Frischmann, even if proper, does not disclose or suggest the stator recited by present claim 12.

Accordingly, reconsideration of the rejection of claim 12 under 35 U.S.C. §103(a) as being unpatentable over the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al., is respectfully requested.

G. Claims 13 and 14 (dependent from claim 1) meet the conditions for patentability because neither the '438 patent, Mischler et al., Frischmann, Vernin et al., nor Yoshizawa et al., either alone or in combination, teaches or suggests the amorphous metal stator of claims 13 and 14.

Claims 13 and 14 were rejected under 35 USC 103(a) on the following basis:

Claims 13 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over the `438 patent, Mischler, Frischmann, and Vernin, in further view of Yoshizawa et al., (US 4881989). The'438 patent, Mischler, Frischmann, and Vernin teach every aspect of the invention except composition of claims 13 and 14. Yoshizawa teaches the composition with similar atomic ranges. It would have been obvious to a person of ordinary skill in. the art at the time of the invention to construct the stator of the '438 patent, Mischler, Frischmann, and Vernin with the amorphous composition of claims 13 and 14 because Yoshizawa teaches the components combine to make an amorphous material with excellent magnetic qualities, and in the specific range because a person of ordinary skill in the art would attempt to optimize the atomic composition to provide the best magnetic material.

Yoshizawa et al. discloses an iron-base soft magnetic alloy having a composition represented by the general formula: $(Fe_{1-a}M_a)_{100-x-y-z-\alpha-\beta-\gamma}Cu_xSi_yB_zM'_\alpha M''_\beta X_\gamma$ wherein M is Co and/or Ni, M' is at least one element selected from the group consisting of Nb, W, Ta, Zr, Hf, Ti and Mo, M" is at least one element selected from the group consisting of V, Cr, Mn, Al, elements in the platinum group, Sc, Y, rare earth elements, Au, Zn, Sn and Re, X is at least one element selected from the group consisting of C, Ge, P, Ga, Sb, In, Be and As, and a, x, y, z, α, β, and γ, respectively, satisfy $0 \leq a \leq 0.5$, $0.1 \leq x \leq 3$, $0 \leq y \leq 30$, $0 \leq z \leq 25$, $5 \leq y+z \leq 30$, $0.1 \leq \alpha \leq 30$, β

≤ 10 and $\gamma \leq 10$, at least 50% of the alloy structure being fine crystalline particles having an average particle size of 100 nm or less. This alloy is said to have low core loss, time variation of core loss, high permeability and low magnetostriction. Yoshizawa et al. also discloses toroidal magnetic cores for use in various transformers, choke coils, saturable reactors, magnetic heads, and the like.

Applicants respectfully traverse the position of the Examiner that the '438 patent, Mischler et al., Frischmann, and Vernin et al. teach every aspect of the invention except the compositions set forth in claims 13 and 14. As set forth above in connection with the discussion concerning the rejection of claim 12 under 35 U.S.C. §103(a), applicants submit that the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al. does not suggest a stator having a plurality of segments, each segment comprising a plurality of layers of amorphous metal strips; each of which layers has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap, required by present claims 13 and 14.

Moreover, the Yoshizawa et al. disclosure does not have any teaching concerning the utility of any composition for the construction of electric motors or other rotating electrical machines. For the reasons set forth hereinabove in connection with the rejection of claim 12, applicants submit that a skilled artisan would not be motivated to combine the Yoshizawa et al. disclosure directed to electronic core applications with the Mischler et al, Frischmann, and '438 disclosures as proposed by the Examiner.

However, even assuming that the combination of Yoshizawa et al. with '438, Mischler et al., Frischmann, and Vernin et al. could properly be made, it would not render obvious the stator called for by applicants' claims 13 and 14. For any stator produced in light of the combined teachings of the cited references would still lack the advantageous structure and properties afforded by applicants' stator, as recited by claims 13 and 14. More specifically, any stator constructed from the combined teachings of the cited references would not contain in combination a structure having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Moreover, such a stator produced from the combined teachings of the cited references would clearly lack the advantageous magnetic properties afforded by the stator of applicants' claims 13 and 14. As set forth at page 16, lines 18-19 and 27-29 of applicants' specification, stators employing nanocrystalline alloy strip are especially preferred for motors wherein minimum size and high-speed operation are desired.

Accordingly, reconsideration of the rejection of claims 13 and 14 under 35 U.S.C. §103(a) over the combination of the '438 patent, Mischler et al., Frischmann, and Vernin et al., with Yoshizawa et al. is respectfully requested.

H. Claims 15-18 (dependent from claim 1), claim 26, and claims 27-33 (dependent from claim 26) meet the conditions for patentability because neither the '438 patent nor Mischler et al., either alone or in combination, teaches or suggests the amorphous metal stator of claims 15-18 and 26-33.

Claims 15-18 and 26-33 were rejected under 35 U.S.C. §103(a) on the following basis:

> **The '438 patent and Mischler teach every aspect of the invention except the core loss and frequency range of the magnetic material. It would have been obvious to a person of ordinary skill in the art at the time of the invention to construct the stator core of the '438 patent and Mischler with the core loss with the formula of claim 15, at 1 for 60 Hz, 12 for 1000 Hz, or 70 at 20000 Hz to optimize the magnetic characteristics of the amorphous material.**

Applicants respectfully traverse this statement. Claims 15-18 inherit structural limitations from claim 1. More specifically, each segment of the stator of claims 15-18 comprises a plurality of layers of amorphous metal strips, and each of layer of strip has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. As discussed hereinabove in connection with the rejection of claims 1, 2, 3, 8, 19-22, and 35, this combination of structural elements clearly is not disclosed or suggested by the combination of the '438 patent and Mischler et al. In fact, for the reasons set forth in that discussion, it is submitted that proposed combination of '438 patent and Mischler et al. teaches away from any stator structure that contains the elements of provisos (i) and (ii).

Moreover, applicants do not agree that claims 15-18 and 26-33 amount merely to optimization of magnetic characteristics of a core. Clearly, neither the '438 nor Mischler et al. patents discloses any numerical value of core loss, let alone a stator having a core loss satisfying the limit imposed by the formula of claim 15 or the specific values set forth in claims 16-18. The advantageously low core loss afforded by applicants' claimed amorphous magnetic component is clearly a result; not a design choice that the skilled worker can readily "dial up" on command.

(See *In re Chu*, 36 USPQ 2d 1089, 1095 [Fed. Cir. 1995], holding that Chu's technical evidence relating to the frailty of fabric filters during pulse-jet cleaning clearly counters the assertion that placement of the catalyst in the baghouse is merely a "design choice." Specifically, the Court held that Chu's evidence regarding the violent "snapping" action during pulse-jet cleaning, the difficulty in stitching compartments including the capacity to withstand high temperatures, and problems encountered from variable path lengths due to settling of the catalyst particles in each compartment militated against a conclusion that placement of the SCR catalyst was merely a "design choice." See also *In re Gal*, 980 F.2d 717, 25 USPQ2d 1076 (Fed. Cir. 1992) wherein a finding of "obvious design choice" was precluded where the claimed structure and the function it performed were different from the prior art.)

Furthermore, applicants respectfully submit that, in any case, the core loss of a magnetic device is not a mere matter of engineering choice, but a consequence of (i) a complex interplay of fundamental material properties, (ii) the thermal and magnetic treatment to which the material is subjected, and (iii) specific details involving the device construction.

The Examiner has acknowleged that core loss and permeability are <u>extrinsic</u> properties of soft magnetic materials. An extrinsic property is one that is not uniquely specified or predictable with a degree of certainty solely as a consequence of a composition of matter. Such properties are known to vary, possibly to a significant degree, as a result of factors such as the processing history of the material, its environment, and its geometric disposition, *inter alia.* Typical extrinsic properties of metals include mechanical strength. In contrast, <u>intrinsic</u> properties are substantially unaffected by processing and other external factors. Intrinsic properties include mass density and electrical conductivity.

Over the years, prior art workers in the soft magnetic materials art have devoted extensive efforts to develop materials and associated processing methods that allow desirable extrinsic properties to be realized in a desired magnetic structure. Notable among those desirable extrinsic properties so fervently sought is low core loss. The present invention is directed to an electric motor comprising a bulk magnetic component that has the outstanding combination of high mechanical strength and low core loss. Notwithstanding the significant expenditure of capital and energy during development efforts consuming more than thirty years, these requirements – high mechanical strength and low core loss – have heretofore been considered to be mutually contradictory.

Moreover, it is well recognized in the art of soft magnetic materials that excessive core losses can arise from a wide variety of factors. Highly magnetostrictive materials, including many amorphous metal compositions, are known to be highly vulnerable to externally or internally imposed stresses. In the presence of stress, contributions to core loss from both the hysteresis and eddy current mechanisms increase dramatically. Insulation of adjacent layers or particles has no effect on these contributions, which arise solely within each layer or particle.

While Mischler et al. recognizes in very general terms the desirability of obtaining low losses and that amorphous metal is <u>promising</u> as a low core loss material <u>for power applications</u> (see e.g. column 1, lines 13-16), no method, general or specific, is disclosed by Mischler et al. to accomplish that objective in the extremely demanding context of electric motor components. More specifically, there is no disclosure or suggestion of the need for processing that mitigates the problems that are known to occur as the result of stresses imposed during manufacture. The severity of these problems in the construction of motor components is recognized, e.g., at column

1, line 55 through column 2, line 25 of U.S. Patent 5,731,649 to Caamano. Accordingly, applicants respectfully submit that the achievement of the low core loss values recited by claims 15-18 and 26-33 in a form that may be incorporated in a motor is not merely a matter of design choice. Rather, it represents an unexpected consequence of the advantageous combination of structure and choice of amorphous material delineated by present claims 15-18 and 26-33. It is therefore submitted that claims 15-18 and 26-33 are patentable over the combination of the '438 patent and Mischler et al.

Accordingly, reconsideration of the rejection of claims 15-18 and 26-33 under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. is respectfully requested.

Claims 28-30 were further rejected as follows:

> **Claims 28-30 are method of making limitations which are not germane to the patentability of the apparatus.**

As set forth hereinabove in connection with the rejection of claims 19-21 under 35 USC §103(a), it is respectfully submitted that heat treatment, with or without application of a magnetic field, structurally alters the material comprised in the claimed stator. These limitations are thus germane to the determination of the patentability of claims 28-29, which recite limitations that correspond to those delineated by claims 19-20. Present claim 30 depends from claim 28, and so inherits its structural limitation as well. As further pointed out above, the '438 patent and Mischler et al. disclosures are devoid of teaching concerning the beneficial improvement in magnetic properties in a magnetic material whose microstructure has been modified by heat treatment. It is therefore submitted that the benefit of heat treatment required by claims 28-30 is not recognized or suggested by the combined teachings of the '438 and Mischler et al. patents.

Accordingly, reconsideration of the rejection of claims 15-18 and 26-33 under 35 U.S.C. §103(a) as being unpatentable over the '438 patent and Mischler et al. is respectfully requested.

I. Claims 19-21 (dependent from claim 1) and claims 28-30 (dependent from claim 26) meet the conditions for patentability because neither the '438 patent, Mischler et al., nor Clark et al., either alone or in combination, teaches or suggests the amorphous metal stator of claims 19-21 and 28-30.

Claims 19-21 and 28-30 were rejected under 35 USC §103(a) on the following basis:

> **Claims 19-21 and 28-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over the '438 patent and Mischler, in further view of Clark et al.(Clark)(US 4,763,030). The '438 patent and Mischler teach every aspect of the invention, except the heat treatment, application of a magnetic field, and annealing the segments. Clark teaches amorphous metal being a continuous cooled after annealed in a magnetic field. It would have been obvious to a person skilled in the art at the time of the invention to construct the stator of `438 and Mischler with the segments continuously annealed then cooled in a magnetic field, as in Clark, to improve the magnetomechanical coupling factors of the amorphous metal.**

The Clark et al. patent discloses a metallic glass ribbon having the formula $Fe_wB_xSi_yC_z$ wherein $0.78 \leq w \leq 0.83$, $0.13 \leq x \leq 0.17$, $0.03 \leq y \leq 0.07$, $0.005 \leq z \leq 0.03$, and $w+x+y+z=1$. The ribbon is annealed to remove mechanical strains and exposed to a magnetic field in the plane of the ribbon and transverse to the long axis of the ribbon. The resulting metallic glass ribbons have very large magnetic coupling coefficients ($k_{33} >0.9$). The treated ribbons are said to be useful in magnetostrictive transducers and in passive listening devices such as hydrophones or pressure sensors. No disclosure is provided by the Clark et al. patent of the use of metallic glass or amorphous metal ribbon in the construction of components of electric motors. Moreover there is no suggestion in Clark et al. that amorphous metal ribbons having high magnetomechanical coupling factor are advantageous for use in construction of an electric motor. In fact, a high

magnetomechanical coupling factor is detrimental to the magnetic properties of materials incorporated in an electric motor. The magnetomechanical coupling factor characterizes a material's efficiency in converting externally imposed, oscillatory electromagnetic energy into internal, vibrational mechanical energy. In an operating motor, any such internal vibration gives rise to noise and dissipation of energy. Since that energy must be taken from the power source, but is not converted into useful mechanical work, the motor's efficiency is unavoidably lessened. Applicants thus submit that the annealing taught by Clark et al. to improve magnetomechanical coupling factor, which requires imposition of a transversely directed magnetic field during the anneal cycle (see, e.g., col. 2, lines 44-49), does not render obvious the heat treatment recited by present claims.

The Examiner has stated that the '438 patent and Mischler et al. teach every aspect of the invention, except the heat treatment, application of a magnetic field, and annealing the segments. This statement is respectfully traversed. As discussed hereinabove in connection with the 103(a) rejection of claims 1, 2, 3, 8, 19-22, and 35 over the '438 patent and Mischler et al., present claim 1 calls for a stator comprised of segments. Each of the segments comprises a plurality of layers of amorphous metal strips, and each of the strips has a top and a bottom surface and is oriented such that (i) a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor, and (ii) when traversing the segment, the flux crosses one air gap. Even taking together the '438 patent and Mischler et al. teachings, there is no suggestion therein concerning a stator that satisfies the combined features of provisos (i) and (ii). Clark et al. do not disclose or suggest use of amorphous metal in electric motor components of any kind, let alone construction of the amorphous metal stator set forth in

present claims 19-22 and 28-30. Clearly, a stator constructed in accordance with the combined teaching of the '438 patent and Mischler et al, even if annealed in the manner taught by Clark et al., would still lack the advantageous combination of structure and properties afforded by applicants' claimed stator. The stator would not comprise amorphous metal strips oriented such that, when traversing a segment, the flux crosses one air gap, as required by present claims 19-21 wherein the flux crosses only one air gap. It would not comprise amorphous metal strips oriented such that a line normal to either of the surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of the rotor. Thus, the Clark et al. teaching does not add to the teachings of the '438 patent and Mischler et al. and cannot be combined therewith to render obvious the invention recited by present claims 19-21.

On the other hand, claims 28-30 inherit from claim 26 the limitation that the stator have a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max}, wherein L is given by the formula $L = 0.0074\, f\, (B_{max})^{1.3} + 0.000282\, f^{1.5}\, (B_{max})^{2.4}$, the core loss, excitation frequency and peak induction level being measured in watts per kilogram, hertz, and teslas, respectively. The significance of low core loss is discussed hereinabove in greater detail in connection with the rejection of claims 15-18 and 26-33 under 35 USC 103(a). Like the '438 patent and Mischler et al. patents applied in the rejection of claims 15-18 and 26-33, Clark et al. does not disclose any value of core loss, let alone a stator having a core loss satisfying the limit imposed by the aforementioned core loss formula. It is thus submitted that the core loss required for the stator recited by claims 28-30 is not disclosed or suggested by any combination of the '438, Mischler et al., and Clark et al. references.

The Examiner has suggested that Clark, along with Yoshizawa and Vernin, merely support Mischler to teach various elements of the amorphous material in magnetic cores. Applicants acknowledge that each of Clark, Yoshizawa, and Vernin provide certain teachings concerning amorphous metals. However, applicants respectfully submit that the Examiner has not pointed to those elements in either of Clark, Yoshizawa, or Vernin that fairly disclose or suggest the particular features and properties set forth in applicants' claims 19-21 and 28-30. It is well established that the mere aggregation of references that individually teach elements of a claim is not sufficient to establish its obviousness under 35 U.S.C. §103(a). See the discussion of *In re Rouffet*, 47 USPQ 2d 1453, 1457 (Fed. Cir. 1998) hereinabove. In the present matter, it is respectfully submitted that the references cited fail to support the rejection given. Specific teaching has not been adduced that establishes a proper motivation for each of the proposed combinations; even when combined, the cited references fail to disclose or suggest every element required by applicants' claims.

In view of the foregoing remarks, it is respectfully submitted that claims 19-21 and 28-30 are not obvious in light of the combination of the '438 patent, Mischler et al. and Clark et al.

Accordingly, reconsideration of the rejection of claims 19-21 and 28-30 under 35 U.S.C. §103(a) over the '438 patent, Mischler et al. and Clark et al. is requested.

J. Claim 36 meets the conditions for patentability because neither Mischler et al. nor Takeuchi et al., either alone or in combination, teaches or suggests the brushless radial flux DC motor claim 36.

Claim 36 was rejected under 35 USC 103(a) on the following basis:

Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Mishler et al. (4255684) and Takeuchi. Mischler teaches every aspect of the invention except the specific core loss of the material. Takeuchi teaches the amorphous stator that has lines normal to the axis of rotation at any points from the upper and lower surfaces along the back iron portion of the core. Takeuchi suggests an amorphous core with low loss magnetic core with to provide a productive magnetic core. It would have been obvious to a person of ordinary skill in the art at the time of the invention to construct the machine of Mischler with a low loss core to provide a productive magnetic core(as taught by Takeuchi), and with the formula of claim 36 because it is merely defining the optimum magnetic characteristics suggested by Takeuchi

Takeuchi et al. discloses a magnetic core having a low core loss and having stable characteristic in a low magnetic permeability region (e.g., a permeability of 100 to 600) obtained by applying a heat treatment in a wet atmosphere containing a limited amount of steam. The core is said to be wound or laminated ferrous amorphous ribbon. Takeuchi et al. does not provide any disclosure or suggestion of a magnetic component suitable for use in an electric motor. In addition, the low permeability which Takeuchi et al. seeks as an objective renders any device produced in accordance with the teaching therein as not suitable for use in an electric motor, let alone applicants' claimed motor, for which at least a moderate permeability is required and a high permeability is highly desired. Further, the objective of low permeability sought by Takeuchi et al. would negate any motivation for the skilled artisan to combine it with Mischler et al. to render obvious the motor of claim 36.

While Takeuchi et al. discloses numerical values of core loss, e.g. in Figures 2, 3, and 7, there is no indication of the conditions under which the values were measured, i.e., values of the excitation frequency and peak induction level. One skilled in the art would recognize that core losses depend strongly on these conditions (see also the discussion in the instant specification at page 20), so that the Takeuchi et al. disclosure at best is indicative of relative losses as a function

of heat treatment condition for the particular cores disclosed therein. A skilled person would further recognize that the Takeuchi et al. patent does not provide sufficient information to permit any comparison between the losses of cores disclosed therein and the stators taught by the present specification. Thus, Takeuchi et al. cannot fairly be read as disclosing or suggesting a component having the specific and unexpectedly low losses afforded by the component recited by claim 36. The significance of the low core loss has been set forth hereinabove in more detail, e.g., in connection with the 103(a) rejection of claims 1, 2, 3, 8, 19-22, and 35. Accordingly, reconsideration of the rejection of claim 36 under 35 U.S.C. §103(a) over Mischler et al. and Takeuchi et al. is respectfully requested.

CONCLUSION

In light of the foregoing remarks, it is respectfully submitted that the amorphous metal stator of claim 1, the amorphous metal stator of claim 22, the amorphous metal stator of claim 26, the brushless radial flux DC motor of claim 34, and the brushless radial flux DC motor of claim 35 are not disclosed or suggested by any combination of the art references applied and thus meet the conditions for patentability. It is further submitted that claims 2-21 dependent from claim 1, claims 23-25 dependent from claim 22, and claims 27-33 dependent from claim 26, are patentable for at least the same reasons as their respective base claims.

Reversal of the rejection of each of claims 1-36 under 35 USC §103(a), and allowance of the present application, are earnestly solicited.

Kindly charge the $320 brief fee, and any other charges or credits related to this Appeal, to Deposit Account No. 01-1125.

Respectfully submitted,

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Appendix I

(Claims On Appeal)

1. An amorphous metal stator for a radial flux motor having a rotor, said stator comprising a plurality of segments, each segment comprising a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) when traversing said segment, said flux crosses one air gap.

2. An amorphous metal stator as recited by claim 1, each of said segments further comprising:
   a) a back-iron section having a first free end and comprising a plurality of contactingly stacked layers of amorphous metal strips; and
   b) a tooth section having a first free end and comprising a plurality of contactingly stacked layers of amorphous metal strips;

   said back-iron section and said tooth section being arranged such that said first free end of said back-iron section contactingly engages said first free end of said tooth section and wherein an air gap is defined between said respective first free ends.

3. An amorphous metal stator as recited by claim 2, further comprising:
   c) an inner restraining means for securing said tooth section against being drawn out of engagement with said back-iron section; and
   d) an outer restraining means for securing said plurality of segments in generally circular abutting relation to each other.

4. An amorphous metal stator as recited by claim 3, wherein said inner restraining means comprises a bonding material that is applied to a substantial portion of said stator to

provide each of said segments with increased mechanical strength, and said outer restraining means comprises a steel band provided peripherally about said stator.

5. An amorphous metal stator as recited by claim 3, wherein said inner restraining means comprises a bonding material that is applied to a substantial portion of said stator, excluding said respective first free ends of said back-iron and tooth sections.

6. An amorphous metal stator as recited by claim 4, wherein said bonding material is an epoxy resin.

7. An amorphous metal stator as recited by claim 3, wherein said inner restraining means partly comprises a bonding material and partly comprises a metal band.

8. An amorphous metal stator as recited by claim 2, said back-iron section being generally arcuate and said tooth section being generally straight.

9. An amorphous metal stator as recited by claim 1, each of said amorphous metal strips having a composition defined essentially by the formula: $M_{70\text{-}85}\ Y_{5\text{-}20}\ Z_{0\text{-}20}$, subscripts in atom percent, where "M" is at least one of Fe, Ni and Co, "Y" is at least one of B, C and P, and "Z" is at least one of Si, Al and Ge; with the provisos that (i) up to 10 atom percent of component "M" can be replaced with at least one of the metallic species Ti, V, Cr, Mn, Cu, Zr, Nb, Mo, Ta, Hf, Ag, Au, Pd, Pt, and W; (ii) up to 10 atom percent of components (Y + Z) can be replaced by at least one of the non-metallic species In, Sn, Sb and Pb; and (iii) up to about one (1) atom percent of the components (M + Y + Z) can be incidental impurities.

10. An amorphous metal stator as recited by claim 9, wherein each of said amorphous metal strips has a composition containing at least 70 atom percent Fe, at least 5 atom percent B, and at least 5 atom percent Si, with the proviso that the total content of B and Si is at least

15 atom percent.

11. An amorphous metal stator as recited by claim 10 wherein each of said amorphous metal strips has a composition defined essentially by the formula $Fe_{80}B_{11}Si_9$.

12. An amorphous metal stator as recited by claim 9, said amorphous metal strips having been heat treated to form a nanocrystalline microstructure therein.

13. An amorphous metal stator as recited by claim 12, wherein each of said amorphous metal strips has a composition defined essentially by the formula $Fe_{100-u-x-y-z-w}R_uT_xQ_yB_zSi_w$, wherein R is at least one of Ni and Co, T is at least one of Ti, Zr, Hf, V, Nb, Ta, Mo, and W, Q is at least one of Cu, Ag, Au, Pd, and Pt, u ranges from 0 to about 10, x ranges from about 3 to 12, y ranges from 0 to about 4, z ranges from about 5 to 12, and w ranges from 0 to less than about 8.

14. An amorphous metal stator as recited by claim 12, wherein each of said amorphous metal strips has a composition defined essentially by the formula $Fe_{100-u-x-y-z-w}R_uT_xQ_yB_zSi_w$, wherein R is at least one of Ni and Co, T is at least one of Ti, Zr, Hf, V, Nb, Ta, Mo, and W, Q is at least one of Cu, Ag, Au, Pd, and Pt, u ranges from 0 to about 10, x ranges from about 1 to 5, y ranges from 0 to about 3, z ranges from about 5 to 12, and w ranges from about 8 to 18.

15. An amorphous metal stator as recited by claim 1, said stator having a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max} wherein L is given by the formula $L = 0.0074\, f\, (B_{max})^{1.3} + 0.000282\, f^{1.5}\, (B_{max})^{2.4}$, said core loss, said excitation frequency and said peak induction level being measured in watts per kilogram, hertz, and teslas, respectively.

16. An amorphous metal stator as recited by claim 15, said stator having a core-loss less than or approximately equal to 1 watt-per-kilogram of amorphous metal material when

operated at a frequency of approximately 60 Hz and a flux density of approximately 1.4T.

17. An amorphous metal stator as recited in claim 15, said stator having a core-loss of less than or approximately equal to 12 watts-per-kilogram of amorphous metal material when operated at a frequency of approximately 1000 Hz and a flux density of approximately 1.0T.

18. An amorphous metal stator as recited in claim 15, said stator having a core-loss of less than or approximately equal to 70 watts-per-kilogram of amorphous metal material when operated at a frequency of approximately 20,000 Hz and a flux density of approximately 0.30T.

19. An amorphous metal stator as recited in claim 1, each of said segments having been subjected to a heat treatment comprising a heating and a cooling portion.

20. An amorphous metal stator as recited in claim 19, a magnetic field having been applied to each of said segments during at least the cooling portion of the heat treatment thereof.

21. An amorphous metal stator as recited in claim 19, said heat treatment having been carried out in a batch or continuous annealing oven

22. An amorphous metal stator for a radial flux motor having a rotor, said stator comprising a plurality of segments, each segment having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) said flux traverses said segment without crossing an air gap, said stator further comprising:

a) an inner restraining means for protecting and strengthening at least said tooth section; and

b) an outer restraining means for securing said plurality of segments in generally circular abutting relation to each other.

23. An amorphous metal stator as recited by claim 22, wherein said inner restraining means comprises a bonding material that is applied to a substantial portion of said stator and that provides each of said segments with increased mechanical strength and wherein said outer restraining means comprises a steel band provided peripherally about said stator.

24. An amorphous metal stator as recited by claim 23, wherein said bonding material is an epoxy resin.

25. An amorphous metal stator as recited by claim 22, wherein said inner restraining means partly comprises a bonding material and partly comprises a metal band.

26. An amorphous metal stator for a radial flux motor having a rotor, said stator comprising a plurality of segments, each segment having a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) said flux traverses said segment without crossing an air gap, said stator having a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max} wherein L is given by the formula $L = 0.0074\, f\, (B_{max})^{1.3} + 0.000282\, f^{1.5}\, (B_{max})^{2.4}$, said core loss, said excitation frequency and said peak induction level being measured in watts per kilogram, hertz, and teslas, respectively.

27. An amorphous metal stator as recited in claim 26, said stator further comprising:

a) an inner restraining means for protecting and strengthening at least said tooth section; and

b) an outer restraining means for securing said plurality of segments in generally circular abutting relation to each other.

28. An amorphous metal stator as recited in claim 26, each of said segments having been subjected to a heat treatment comprising a heating and a cooling portion.

29. An amorphous metal stator as recited in claim 28, a magnetic field being applied to each of said segments during at least the cooling portion of the heat treatment thereof.

30. An amorphous metal stator as recited in claim 28, said heat treatment being carried out in a batch or continuous annealing oven.

31. An amorphous metal stator as recited by claim 26, said stator having a core-loss less than or approximately equal to 1 watt-per-kilogram of amorphous metal material when operated at a frequency of approximately 60 Hz and a flux density of approximately 1.4T.

32. An amorphous metal stator as recited in claim 26, said stator having a core-loss of less than or approximately equal to 12 watts-per-kilogram of amorphous metal material when operated at a frequency of approximately 1000 Hz and a flux density of approximately 1.0T.

33. An amorphous metal stator as recited in claim 26, said stator having a core-loss of less than or approximately equal to 70 watts-per-kilogram of amorphous metal material when operated at a frequency of approximately 20,000 Hz and a flux density of approximately 0.30T.

34. An amorphous metal stator as recited in claim 26, wherein each of said strips has a composition defined essentially by the formula: M_{70-85} Y_{5-20} Z_{0-20}, subscripts in atom percent, where "M" is at least one of Fe, Ni and Co, "Y" is at least one of B, C and P, and "Z" is at least one of Si, Al and Ge; with the provisos that (i) up to 10 atom percent of component "M" can be replaced with at least one of the metallic species Ti, V, Cr, Mn, Cu, Zr, Nb, Mo, Ta, Hf, Ag, Au, Pd, Pt, and W; (ii) up to 10 atom percent of components

(Y + Z) can be replaced by at least one of the non-metallic species In, Sn, Sb and Pb; and (iii) up to about one (1) atom percent of the components (M + Y + Z) can be incidental impurities.

35. A brushless radial flux DC motor comprising:

a) an amorphous metal stator and a rotor disposed for rotation therewithin, said stator comprising a plurality of segments, each segment comprising a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) when traversing said segment, said flux crosses one air gap; and

b) means for supporting said stator and said rotor in predetermined positions relative to each other.

36. A brushless radial flux DC motor comprising:

a) an amorphous metal stator and a rotor disposed for rotation therewithin, said stator comprising a plurality of heat-treated segments, each segment comprising a plurality of layers of amorphous metal strips, each of which has a top and a bottom surface and is oriented such that (i) a line normal to either of said surfaces at substantially any point thereon is substantially perpendicular to the axis of rotation of said rotor, and (ii) said flux traverses said segment without crossing an air gap, and said stator having a core loss less than "L" when operated at an excitation frequency "f" to a peak induction level B_{max} wherein L is given by the formula $L = 0.0074\ f\ (B_{max})^{1.3} + 0.000282\ f^{1.5}\ (B_{max})^{2.4}$, said core loss, said excitation frequency and said peak induction level being measured in watts per kilogram, hertz, and teslas, respectively; and

b) means for supporting said stator and said rotor in predetermined positions relative to each other.

Appendix II
Figures Referenced In Brief

Fig. A1
(DE 2805438)

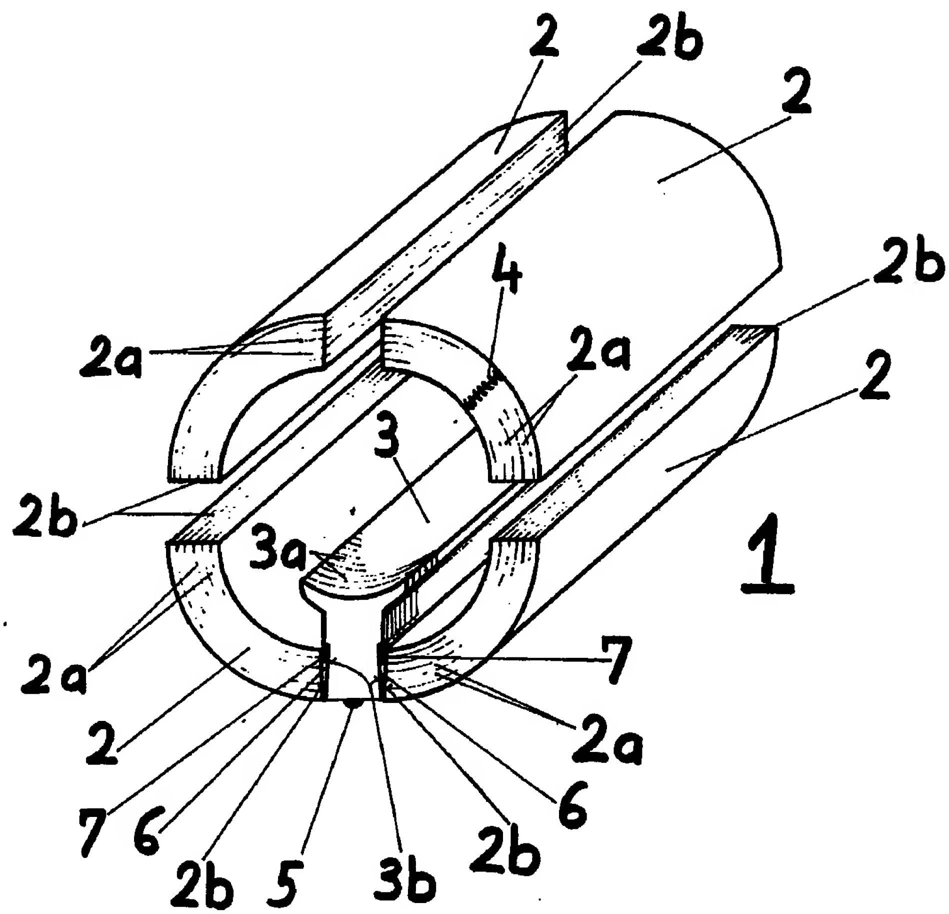

Fig. A2
(DE 2805438)

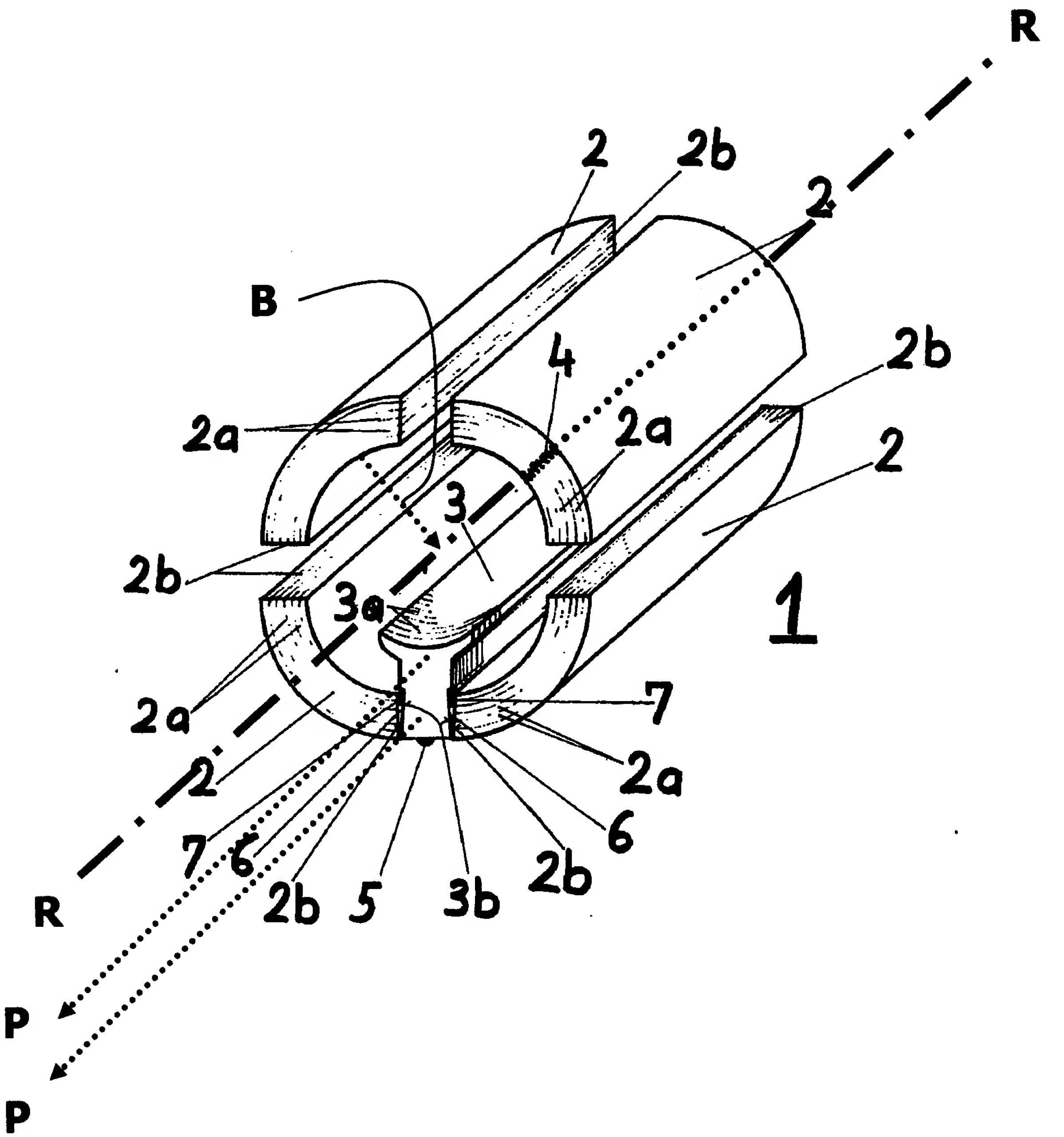

Fig. A3
(DE 2805438)

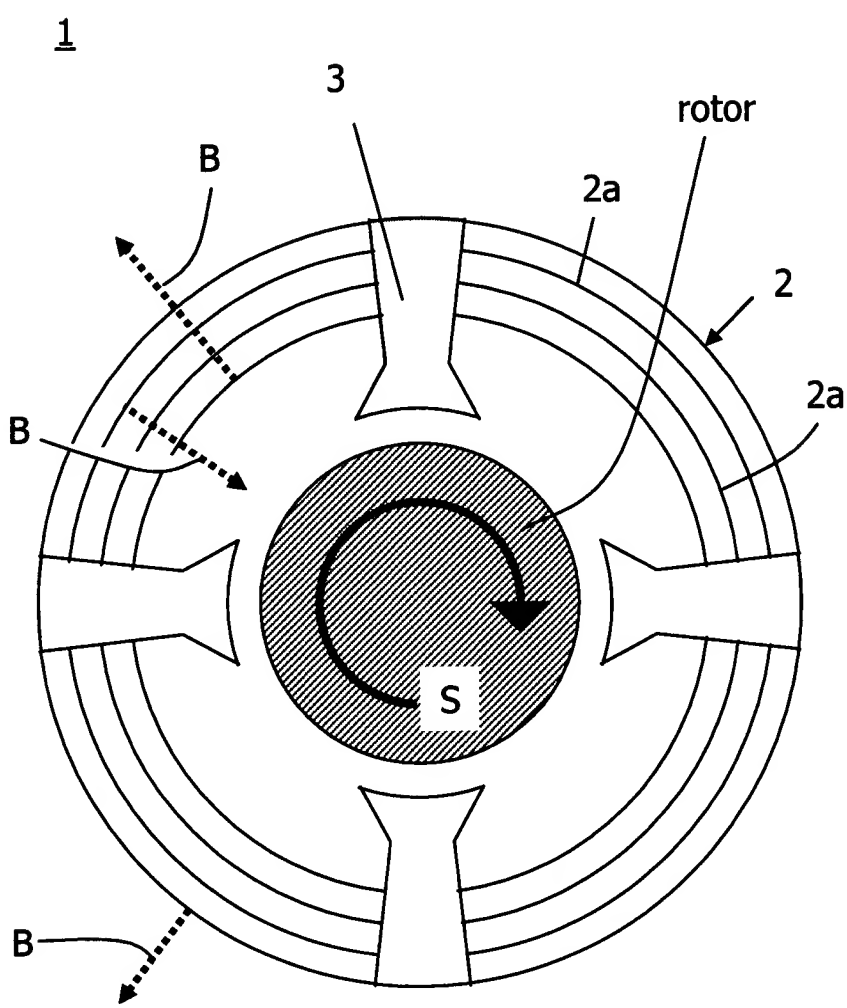

Fig. A4
(Mischler et al.)

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Fig. 1